OECD Nuclear Energy Agency Activities Related to Fast Reactor Development

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IAEA, Vienna
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Outline

- **OECD/NEA Mission and Membership**
- **Modelling and Validation**
  - Nuclear Data for Advaceded Reactors
  - Databases of Integral Experiments
- **Reactor Systems, Materials and the Fuel Cycle**
  - Sodium Cooled Fast Reactor Studies
  - Heavy Liquid Metal Technologies
  - Innovative Fuels & Materials
  - Advanced Fuel Cycle Scenarios, P&T, Recycling Technologies
- **Advanced reactor systems**
  - Regulatory and Safety Issues
  - Future energy market needs
- **Concluding remarks and proposals for collaboration**

NEA Mission

- To assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal basis required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes
- To provide authoritative assessments and to forge common understanding on key issues, as support to government decisions on nuclear energy policy and as input to broader OECD policy analyses in areas such as energy and sustainable development

- **Forum for sharing national experience**

  Catalyst for developing consensus
- **Centre of excellence**

  Network of over 4000 national experts

  To pool and maintain expertise
- **Managerial skills for co-ordinating multi-national R&D projects**

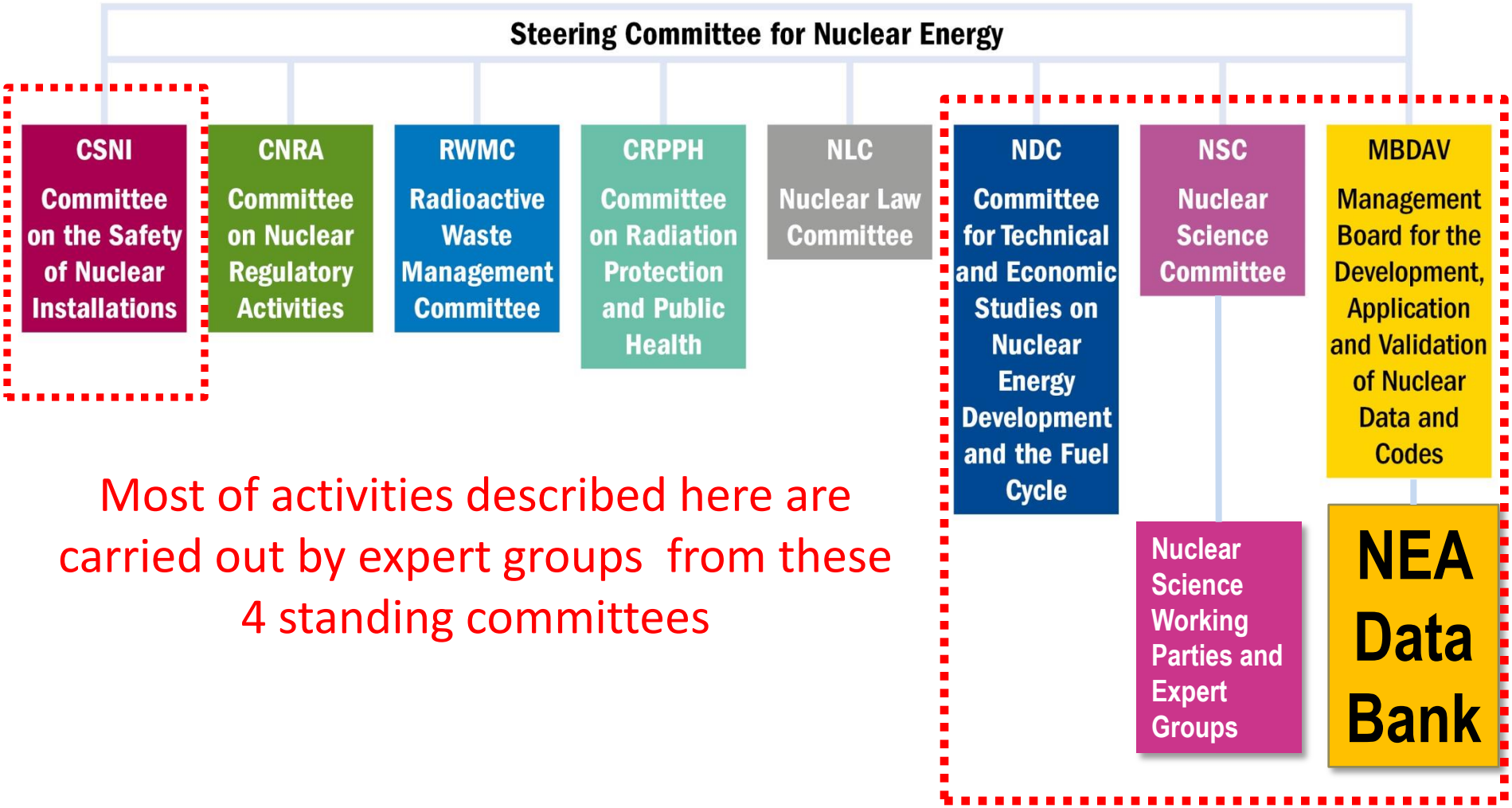
  More than 50 years of experience in managing such projects for the benefit of participating countries

NEA Member Countries

Argentina and Romania will join NEA in fall 2017

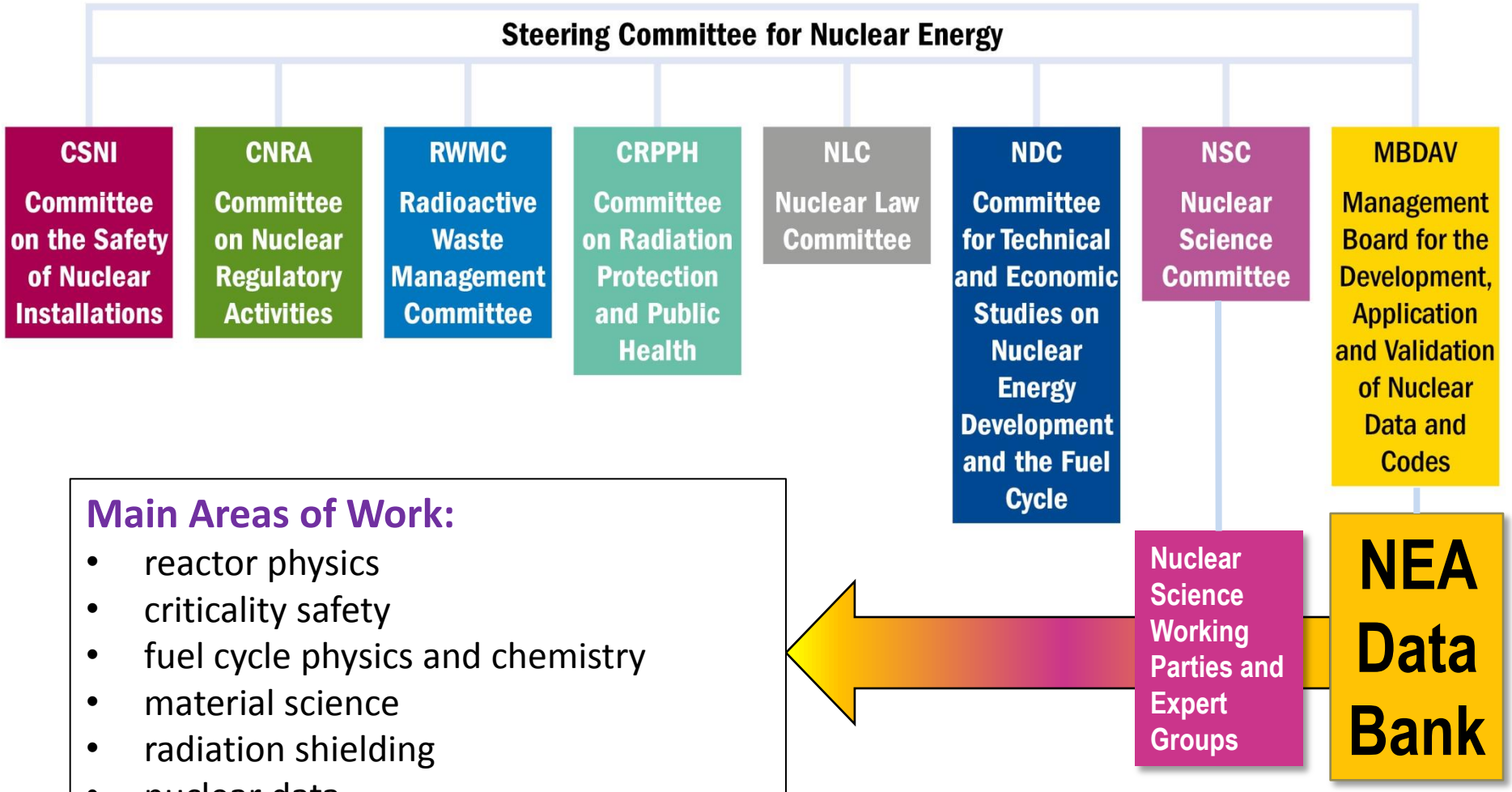
The NEA's current membership consists of 31 countries in Europe, North America and the Asia-Pacific region. Together they account for approximately 85% of the world's installed nuclear capacity.

NEA Committees



Most of activities described here are carried out by expert groups from these 4 standing committees

NSC & DB: Main Areas of Work



Main Areas of Work:

- reactor physics
- criticality safety
- fuel cycle physics and chemistry
- material science
- radiation shielding
- nuclear data

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Nuclear Data: Ongoing Activities

Working Party on International Nuclear Data Evaluation Co-operation (WPEC)

NEA has organised a world-wide cooperation in the area of Nuclear Data evaluation since 1989. WPEC provides framework for co-operative activities between the major nuclear data evaluation projects (e.g. ENDF, JEFF, JENDL, BROND and CENDL)

Subgroups

- SG C — High Priority Request List – HPRL
- EG-GNDS — EG on Recommended Definition of a General Nuclear Database Structure
- SG 37 — Improved fission yield evaluation methodologies
- SG 38 — A modern nuclear database structure beyond the ENDF format
- SG 39 — Methods and approaches to provide feedback from nuclear and covariance data adjustment for improvement of nuclear data files
- SG 40 — CIELO Pilot Project
- SG 41 — Improving nuclear data accuracy of ^{241}Am and ^{237}Np capture XSs
- SG 42 — Thermal Scattering Kernel S(a,b): Measurement, Eval. & Appl
- SG 43 — Code infrastructure to support a modern general nuclear database (GND) structure

Nuclear Data: Ongoing Activities (1/2)

Working Party on International Nuclear Data Evaluation Co-operation (WPEC)

Sg. 39 (Follow-up of Sg. 33): Methods and approaches to provide feedback from nuclear and covariance data adjustment

- **Objective** is to provide criteria and practical approaches to use effectively the results of sensitivity analyses and cross section adjustments for feedback to ND evaluators and experimentalists.
- **Focus** on SFR energy region.
- **Deliverables**: "Summary of Methodology" and "Comments on Covariance Data" (Report **NEA/NSC/R(2016)6)**

Sg. 40: Pilot project of a Collaborative International Evaluated Library Organization (CIELO)

- Collaborative work with the **objective** to produce improved evaluations/ covariances for ^{235,238}U, ^{239}Pu, ^{56}Fe, ^{16}O and ^{1}H.
- **Deliverables:** Evaluated files: CIELO/A , CIELO/B– 2017; Documents issues in NDS 2018 big paper; Final report in 2018.

Nuclear Data: Ongoing Activities (2/2)

Working Party on International Nuclear Data Evaluation Co-operation (WPEC)

Sg. 41: Improving nuclear data accuracy of ^{241}Am and ^{237}Np capture cross-sections

- **Objectives:**
  - Provide recommendation of best practices, methods and international framework for improving nuclear data accuracy
  - Update of cross-sections and covariances
- **Deliverables:**
  - Progress on decay data, differential data, energy integrated data, and evaluations
  - Final report in 2018

Nuclear Data: Proposals for New Activities

Working Party on International Nuclear Data Evaluation Co-operation (WPEC)

WPEC meetings are held this week

SG44: "Investigation of Covariance Data in General Purpose Nuclear Data Libraries"

- Assess differences/similarities for different evaluated nuclear data files
- Methods for systematic and consistent evaluation of covariance data in the whole energy range

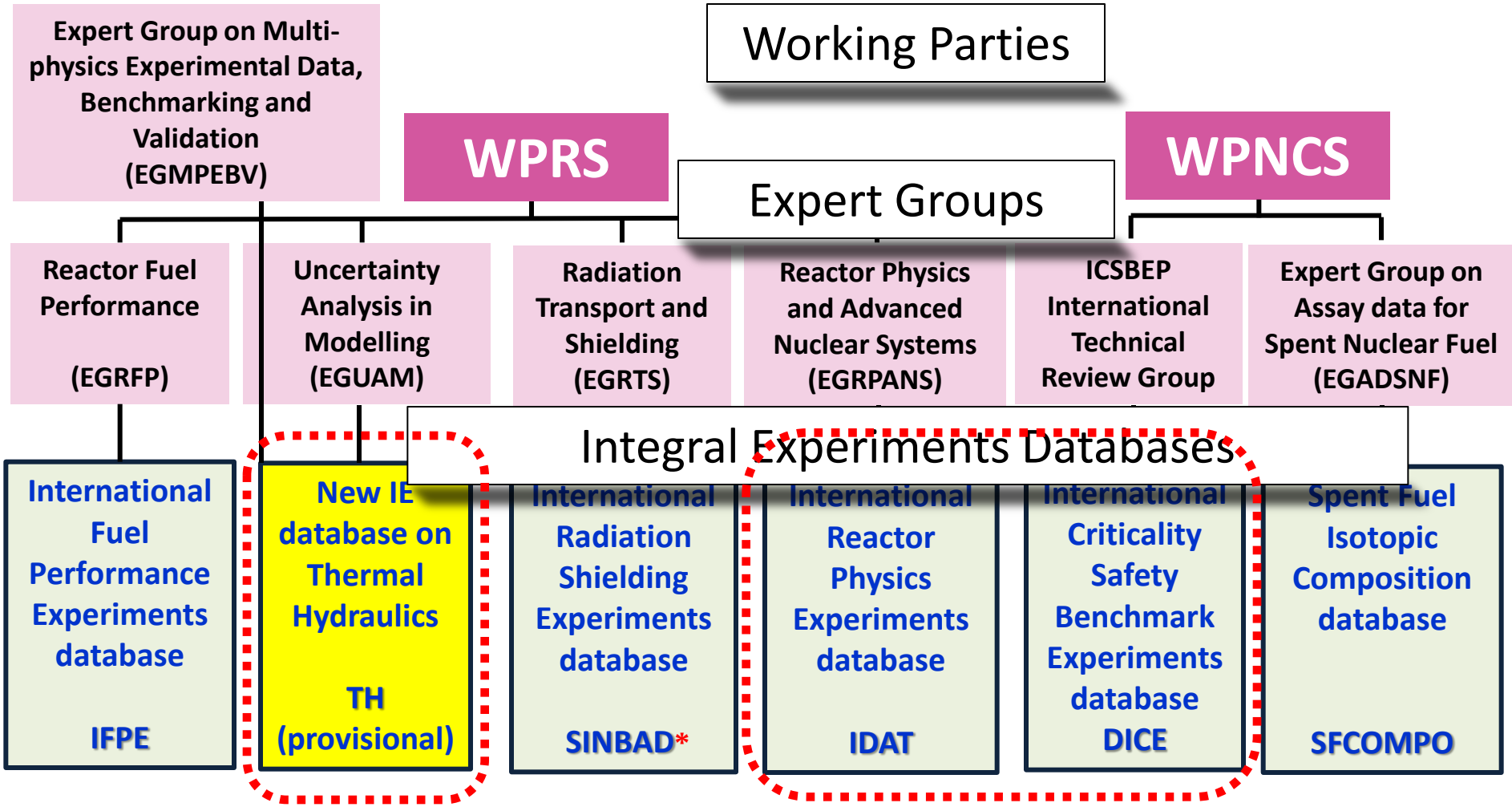
SG45: "The Validation of Nuclear Data Libraries (VaNDaL) project"

- Benchmark suites for the validation of nuclear data libraries
- Generate prototype Q&A requirements, specification and tools

SG46: "Efficient and Effective Use of Integral Experiments for Nuclear Data Validation"

- Selecting appropriate experiments to provide separate effects
- Guidelines on the use of sensitivity/covariances, target accuracies, …

NEA Integral Experiments (IE) Databases



*SINBAD is developed in cooperation with RSICC, USA

New Thermal-hydraulics Database

- Collection and structuring of information for an electronic database to retrieve appropriate benchmarks for code validation
- LWR related data scattered inhomogeneously across multiple sources
- FR related data will be part of the TH database
- Database will be released in 2018 and consist of two interconnected parts:

A. Test facility descriptions

Facility descriptions collected from many sources, including **CSNI publications:**

- IET facilities(41) : Table/references from S-SOAR
- SET facilities(136) : **CSNI**-R1993-14, **CSNI**-R1996-16

B. Cross reference matrices

Link Scenarios-Test types-Phenomena-Test facilities
Reference data sources:

- IET facilities: **CSNI**-R1996-17, **CSNI**-R2001-4, TRACE V5.0 report
- SET facilities: **CSNI**-R1993-14

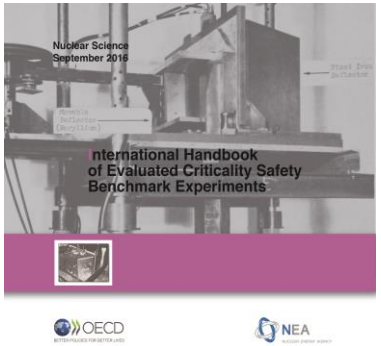
Critical Experiments

International Criticality Safety Benchmark Evaluation Project (ICSBEP)

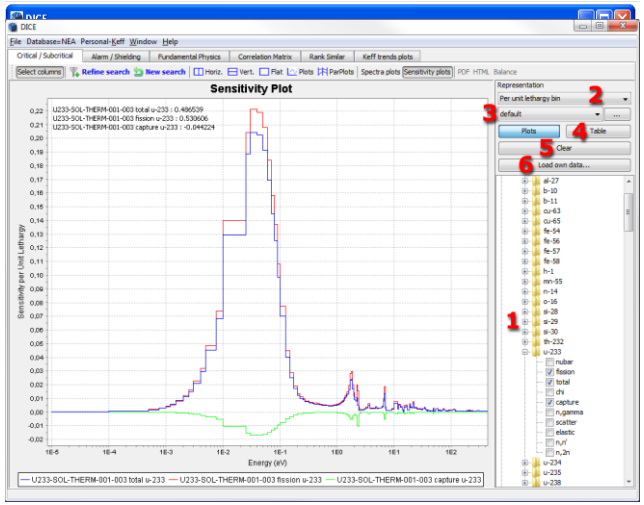
- Est 1992/1995. Handbook Released Yearly

The latest edition of the Handbook contains

- 4916 critical, near-critical and sub-critical configurations
- 231 alarm/shielding and fundamental physics experiments
- **686 Fast Critical Configurations/203 Series conducted in BFS, ZPPR/ZPR, ZEBRA, other fast facilities**
- Distributed on DVD, available on-line



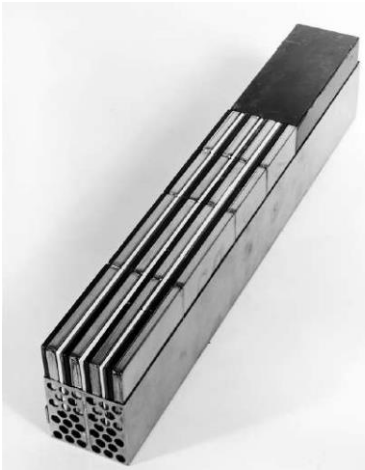
Database for the International Criticality Safety Benchmark Evaluation Project (DICE)



- Allows easy access to benchmark data and supplemented calculated data (neutron balance, flux, reaction rate, k_{eff} sensitivity to neutron cross sections, C/E from several codes/cross-section sets etc.)
- Trend and identify suitable benchmark experiments
- Included on the ICSBEP Handbook DVD, available on-line
- On-going work on experimental correlations

https://www.oecd-nea.org/science/wpncs/icsbep/

DICE Contains Supplementary Information: Example ZPPR/ZPR Correlation Matrix of Uncertainties*



	HMF 055 001	HMF 060 001	HMF 061 001	HMF 067 001	HMF 067 002	HMF 070 001	HMF 070 002	HMF 070 003	HMF 075 001	HMI 001 001	HMM 012 001	ICF 004 001	ICI 005 001	IMF 010 001	IMF 012 001	IMF 013 001	IMF 014 001	IMF 014 002	IMF 015 001	IMF 016 001
HMF055-001	1000	300	250	290	290	260	250	270	210	210	270	480	290	220	330	280	300	310	540	370
HMF060-001	300	1000	510	880	880	840	840	850	430	680	540	530	580	440	330	890	870	880	540	480
HMF061-001	250	510	1000	500	500	440	430	450	870	370	760	470	510	460	280	480	530	550	480	430
HMF067-001	290	880	500	1000	960	930	940	940	420	770	520	510	560	430	320	960	900	900	530	460
HMF067-002	290	880	500	960	1000	940	940	940	420	780	520	510	560	430	310	960	900	900	520	460
HMF070-001	260	840	440	930	940	1000	940	930	370	780	470	460	500	380	280	930	860	850	470	410
HMF070-002	250	840	430	940	940	940	1000	940	360	800	460	450	490	370	280	940	840	840	460	400
HMF070-003	270	850	450	940	940	930	940	1000	380	790	480	470	510	390	290	940	860	860	480	420
HMF075-001	210	430	870	420	420	370	360	380	1000	310	810	370	420	360	230	400	430	450	380	340
HMI001-001	210	680	370	770	780	780	800	790	310	1000	380	370	410	310	230	760	670	670	380	330
HMM012-001	270	540	760	520	520	470	460	480	810	380	1000	470	520	400	290	500	550	570	480	420
ICF004-001	480	530	470	510	510	460	450	470	370	370	470	1000	650	820	520	510	690	670	910	910
ICI005-001	290	580	510	560	560	500	490	510	420	410	520	650	1000	690	380	540	650	660	630	640
IMF010-001	220	440	460	430	430	380	370	390	360	310	400	820	690	1000	440	440	650	620	750	910
IMF012-001	330	330	280	320	310	280	280	290	230	230	290	520	380	440	1000	310	400	390	520	510
IMF013-001	280	890	480	960	960	930	940	940	400	760	500	510	540	440	310	1000	970	930	520	470
IMF014-001	300	870	530	900	900	860	840	860	430	670	550	690	650	650	400	970	1000	960	670	680
IMF014-002	310	880	550	900	900	850	840	860	450	670	570	670	660	620	390	930	960	1000	660	650
IMF015-001	540	540	480	530	520	470	460	480	380	380	480	910	630	750	520	520	670	660	1000	860
IMF016-001	370	480	430	460	460	410	400	420	340	330	420	910	640	910	510	470	680	650	860	1000

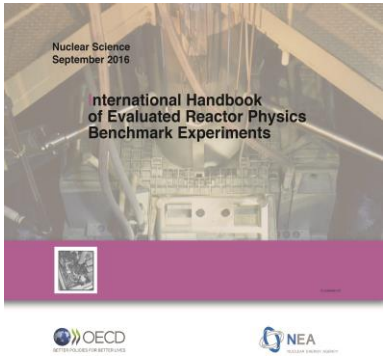
Uncertainty Components

Uncertainty Term	IMF010	PMI 002	IMF013	IMF014
Steel in Matrix Tubes	12	106,	0	0
Depleted Uranium in Reflectors	26	0	4	27
Steel in Drawers	1	0	4	27
Kel-F	6	0	1	2
Depleted Uranium in Core	94	0	0	0
Enriched Uranium	69	0	73	79
Room Return	3	2	52	43
Matrix Interface Gap	6	7	0	5
Plate Axial Position	6	0	0	0
Matrix Tube Pitch	17	37	45	26
Temperature	4	0	4	4
Inhours to k	7	3	9	18
Graphite	0	16	0	0
Plutonium	0	33	0	0
Stainless Steel in Reflector	0	40[2]	0	0
Nominal Plate Dimensions	0	6	0	0
Aluminum[1]	0	0	12	11
Tungsten	0	0	0	10
Total of above in Quadrature	122	127	102	101
Transformation	210	220	210	200
Total (section 3.5)	240	260	230	220

*Provided by ANL (R. McKnight)

Reactor Physics Experiments

International Reactor Physics Experiment Evaluation (IRPhE) Project



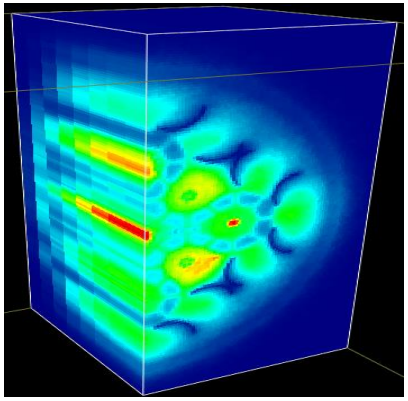
- Initiated by NEA/NSC in 1999
- IRPhE Handbook contains benchmark data for reactor-type experiments:

  reactivity effects/coefficients, spectral indices, reaction rates, kinetic parameters, and others

The 2017 edition of the Handbook contains

- 146 experimental series performed at 50 nuclear facilities
- **25 Liquid Metal Fast Reactor Experiments performed in BFS, ZPPR/ZPR and other facilities**
- Distributed on DVD, available on-line

International Reactor Physics Handbook Database and Analysis Tool (IDAT)



- Released in 2013
- Allows easy access to benchmark data and supplemented calculated data
- Trend and identify suitable benchmark experiments
- Included on the IRPhE Handbook DVD, available on-line

https://www.oecd-nea.org/science/wprs/irphe/

IDAT Application: ^{237}Np (f)/^{239}Pu (f) in IRPhE

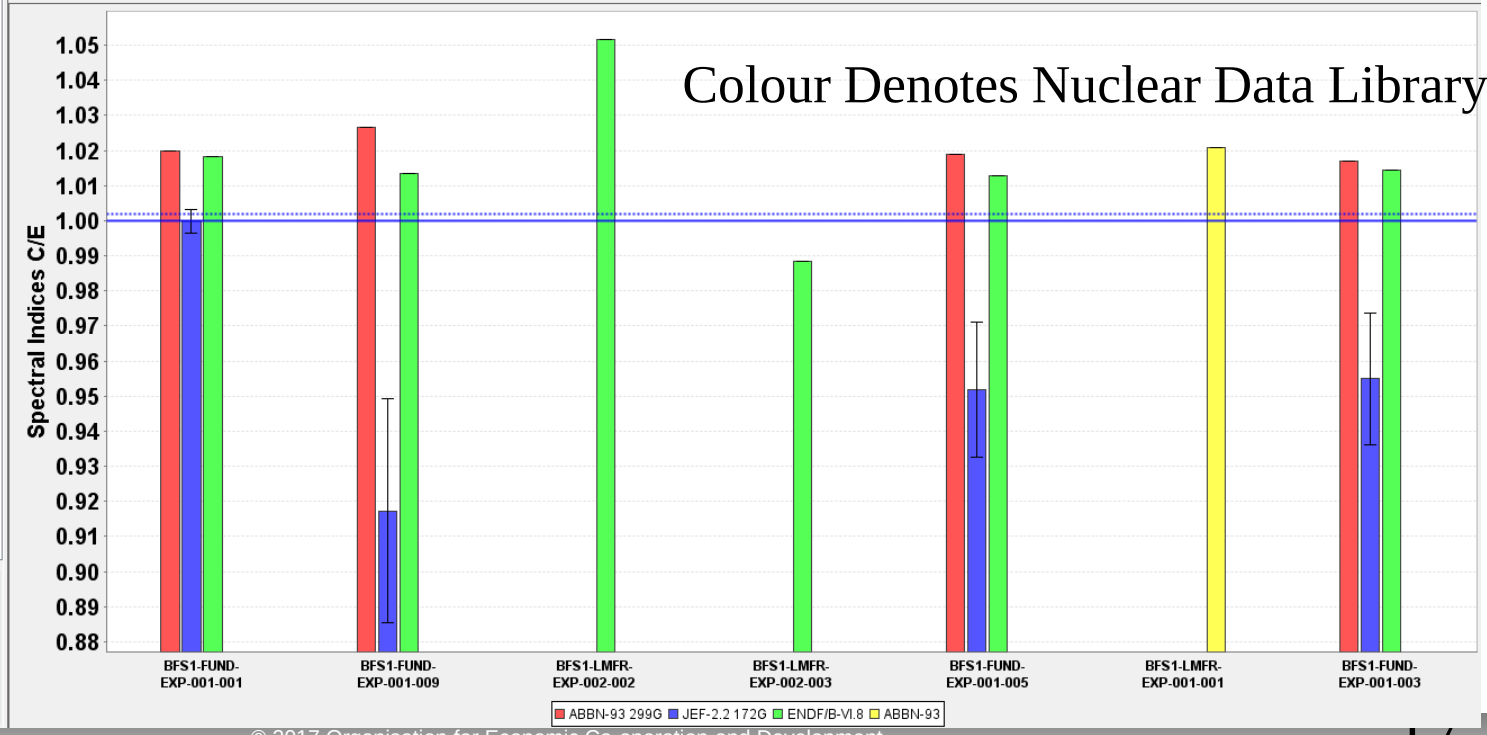
File Database=NEA Window Help

Search | Rank Similar | CRIT | δ CRIT | BUCK | SPEC | REAC | COEF | KIN | RRATE | POWDIS

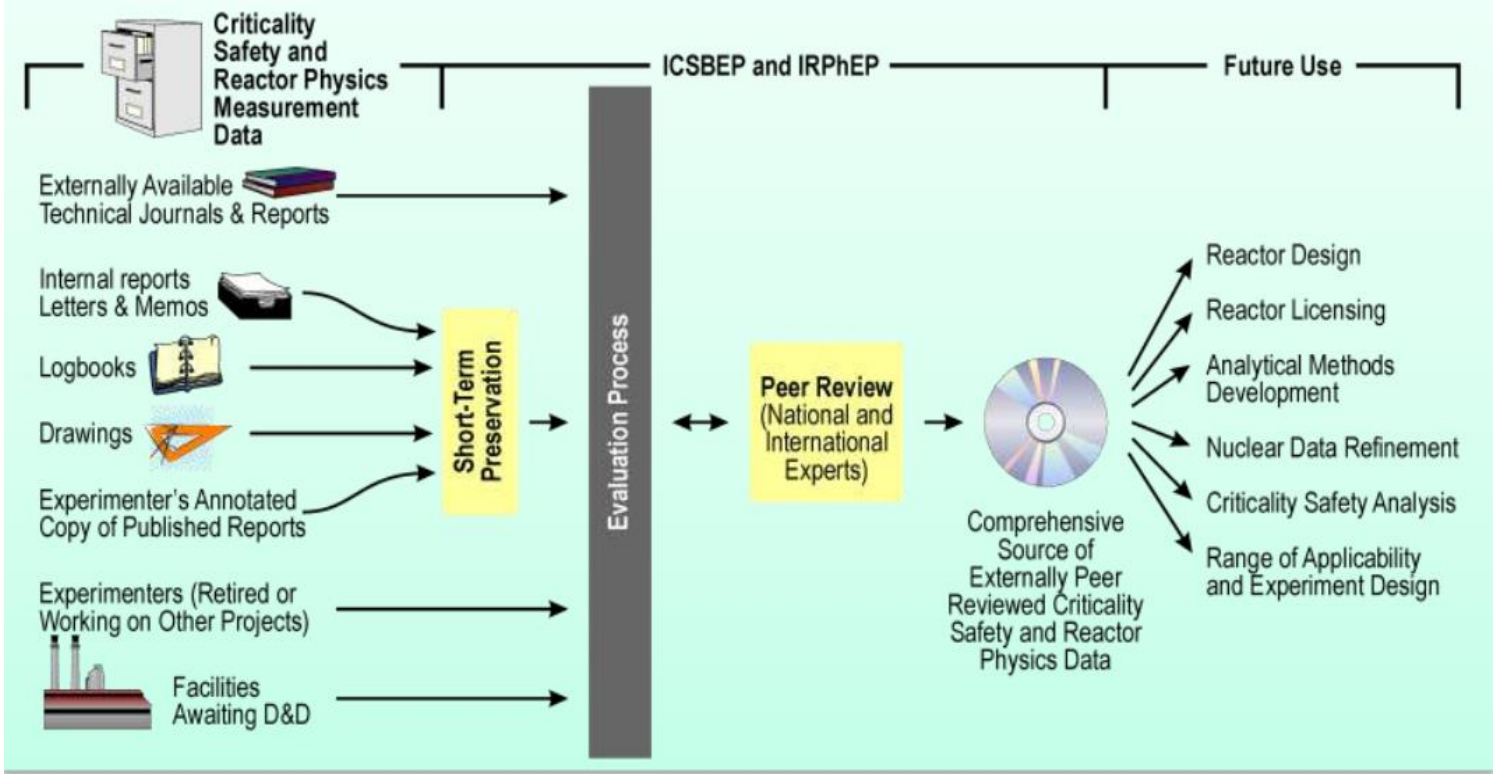
Filter
- Reactor name
- Reactor type
- Facility type
- Devices
- Reac. Nums.
  - Am241-Fission
  - Am243-Fission
  - Ce143
  - Cm244-Fission
  - Cm245-Fission
  - Dy164-Capture
  - H1-Elastic
  - In115-Capture
  - Li-Capture
  - Mn55-Capture
  - Np237-Capture
  - **Np237-Fission**
  - Pu238-Fission
  - Pu239-Fission
  - Pu240-Fission
  - Pu241-Fission
  - Pu242-Fission
  - Th232-Fission
  - U233-Fission
  - U235-Epithermal Fission
  - U235-Fission
  - U238+Cd-Capture
  - U238-Capture
  - U238-Epithermal Capture
  - U238-Fission
- Reac. Denoms.
  - Dy164-Capture
  - Fuel+Cd-Fission
  - Fuel-Fission
  - None
  - **Pu239-Fission**
  - U235+Cd-Thermal Fission
  - U235-Fission
  - U238+Cd-Capture
  - U238+Cd-Thermal Capture
  - U238-Fission
- Codes
- Libraries

Plot options
Averaging: Arithmetic
Group by: Case ID
...and: Library
Sort by: Average increasing
Top 10 , over 100 points

Case ID	DEVICE	REACTION_NUMERATOR	REACTION_DENOMINATOR	E. Mean	E. Std dev	E. Uncertainty RMS	Code	Library	C. Mean	C. Std dev	C. Uncertainty RMS	C/E
BFS1-FUND-EXP-001-001	Fission Chamber	Np237-Fission	Pu239-Fission	0.302	0	2.6%	APOLLO2	JEF-2.2 172G	0.3009	0	0.2%	0.996358
BFS1-FUND-EXP-001-001	Fission Chamber	Np237-Fission	Pu239-Fission	0.302	0	2.6%	MCNPX	JEF-2.2 172G	0.303	0	0.7%	1.003311
BFS1-FUND-EXP-001-001	Fission Chamber	Np237-Fission	Pu239-Fission	0.3135	0.0115	2.7%	MCNP5	ABBN-93 299G	0.31945	0.00505	0.5%	1.019761
BFS1-FUND-EXP-001-001	Fission Chamber	Np237-Fission	Pu239-Fission	0.3135	0.0115	2.7%	MCNP5	ENDF/B-VI.8	0.31905	0.00565	0.5%	1.018413
BFS1-FUND-EXP-001-003	Fission Chamber	Np237-Fission	Pu239-Fission	0.0533	0	2.8%	APOLLO2	JEF-2.2 172G	0.0499	0	0.6%	0.93621
BFS1-FUND-EXP-001-003	Fission Chamber	Np237-Fission	Pu239-Fission	0.0533	0	2.8%	MCNPX	JEF-2.2 172G	0.0519	0	1.2%	0.973734
BFS1-FUND-EXP-001-003	Fission Chamber	Np237-Fission	Pu239-Fission	0.0542	9e-4	2.9%	MCNP5	ABBN-93 299G	0.0551	1e-4	1.3%	1.016855
BFS1-FUND-EXP-001-003	Fission Chamber	Np237-Fission	Pu239-Fission	0.0542	9e-4	2.9%	MCNP5	ENDF/B-VI.8	0.05495	7.5e-4	1.0%	1.014347
BFS1-FUND-EXP-001-005	Fission Chamber	Np237-Fission	Pu239-Fission	0.052	0	2.9%	APOLLO2	JEF-2.2 172G	0.0485	0	1.4%	0.932692
BFS1-FUND-EXP-001-005	Fission Chamber	Np237-Fission	Pu239-Fission	0.052	0	2.9%	MCNPX	JEF-2.2 172G	0.0505	0	1.2%	0.971154
BFS1-FUND-EXP-001-005	Fission Chamber	Np237-Fission	Pu239-Fission	0.0542	0.0022	2.9%	MCNP5	ABBN-93 299G	0.0551	1e-3	1.5%	1.019033
BFS1-FUND-EXP-001-005	Fission Chamber	Np237-Fission	Pu239-Fission	0.0542	0.0022	2.9%	MCNP5	ENDF/B-VI.8	0.05485	9.5e-4	0.9%	1.01295
BFS1-FUND-EXP-001-009	Fission Chamber	Np237-Fission	Pu239-Fission	0.0375	0	3.2%	APOLLO2	JEF-2.2 172G	0.0332	0	0.3%	0.885333
BFS1-FUND-EXP-001-009	Fission Chamber	Np237-Fission	Pu239-Fission	0.0375	0	3.2%	MCNPX	JEF-2.2 172G	0.0356	0	2.0%	0.949333
BFS1-FUND-EXP-001-009	Fission Chamber	Np237-Fission	Pu239-Fission	0.0377	2e-4	2.9%	MCNP5	ABBN-93 299G	0.0387	0.0011	1.8%	1.026709
BFS1-FUND-EXP-001-009	Fission Chamber	Np237-Fission	Pu239-Fission	0.0377	2e-4	2.9%	MCNP5	ENDF/B-VI.8	0.0382	5e-4	1.2%	1.013361
BFS1-LMFR-EXP-001-001	Fission Chamber	Np237-Fission	Pu239-Fission	0.269	0	3.3%	TRIGEX	ABBN-93	0.2746	0	0.0%	1.020818
BFS1-LMFR-EXP-002-002	Fission Chamber	Np237-Fission	Pu239-Fission	0.233	0	2.1%	MCNP5	ENDF/B-VI.8	0.245	0	0.8%	1.051502



Benchmark Process General Overview



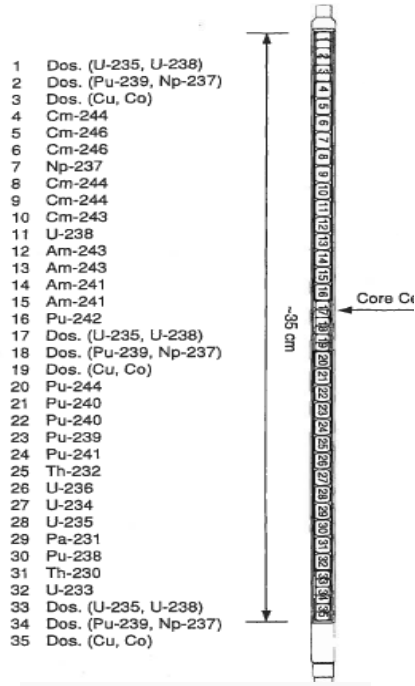
These are Handbooks or Reference Books

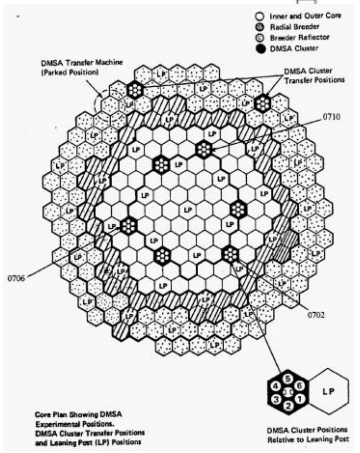
- For the benefit of the user
- Orderly layout to assist the user
- Information is always in the same location
- Information has been rigorously verified

Not a Compilation of Technical Reports!

Dounreay Prototype Fast Reactor Minor Actinide Measurements

- PFR was a 630 MW(t) SFR, that operated from 1975 to 1994
- Fuel was PuO_2 + UO_2
- Collaboration between UK, ORNL to irradiate actinide samples
- Actinide pins were manufactured in the USA, shipped to the UK and then put in PFR.
- 4 pins were irradiated, the longest irradiation was for 492 EFPD, July 1982-July 1988
- Samples also sent to JAEA for PIE and a cross comparison was done.
- Creating a benchmark to perform full core depletion on the irradiated minor actinide pins. The Major uncertainty is core loading history.
- In contact with UK experts who did the original analysis.
- Candidate for unique IRPhE Benchmark.





Securing the UK Fast Reactor Archive

The NEA has initiated an investigation of what could be done to make UK Fast Reactor data available to benefit designers and assessors of future fast reactor systems.

Main tasks:

- Determine nature of data generated by the UK Fast Reactor Programme and its state of preservation
- Preparation of plan for retrieval and preservation
- If valuable archived material is considered to be in vulnerable location, arrange to bring to ‘safe-haven’
- Prepare report on the UK Fast Reactor fuel programme including its supporting data

Much of the work described here was undertaken by Mr C.V. Gregory, formerly Director for Fast Reactors, UKAEA.

Securing the UK Fast Reactor Archive: Sources of Information

- **UKAEA**
  - In the final months of the UKAEA fast reactor project a “super archive” was created. Archive was bequeathed to AEA (Technology), a successor to UKAEA, later to be privatised.
  - A few years after privatisation AEAT withdrew from nuclear work. It is understood that those elements of the archive associated with fast reactor fuel technology were taken over by BNFL.
- **North Highland College in Thurso**
  - Significant collection of old journals (e.g. Journal of the BNES, Annals of Nuclear Engineering, Annual Review of Nuclear Science, Journal of Nuclear Science, Nuclear Safety etc).
  - No longer wishes to house the collection - steps being taken to catalogue and store these items.
- **Private archives**
  - A number of senior staff from the FR Programme kept their private archives when realiased that no formal system to be created. Three private archives have been amalgamated as part of the present project.

Integral Experiments for Minor Actinides Management

Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management (EGIEMAM-II)

Scope: Improve knowledge of MA nuclear data and to support the MA management technology development with reliable accuracy, and sufficient anticipation, reactor physics and irradiation experiments require specific actions by international collaboration.

Report released by EGIEMAM in Feb. 2015 highlights specific actions through international collaboration and required experimental studies:

- Reaction rate measurements;
- Small sample reactivity worth measurements;
- Irradiation experiments;
- Mock-up experiments with large inventory of MAs (in the future).

Content of the EGIEMAM-II Final Report (by 2018)

2. Identifications of systems of interest and associated target uncertainties
    2.1. Review of recommendation by EGIEMAM
    2.2. Review of MA uncertainties and target accuracy requirements: from WPEC/SG26 to present
    2.3. Consideration for possible impact of the potential experimental program on reduction of uncertainties
    2.4. Identification of other MA-Burner system based on the benchmark analysis
        2.4.1. Low Void SFR Burner Core
        2.4.2. MOlten Salt Advanced Reactor Transmuter (MOSART)
3. Joint design of reactor physics MA measurements in selected facilities for international collaboration
    3.1. Review of candidate experimental facilities and assessment of the new measurement techniques for reaction rate and reactivity
        3.1.1. Review of candidate experimental facilities (including current status and future plan)
            BFS, FCA, MINERVE (ERMINE program), NRAD, TAPIRO, VENUS-F
        3.1.2. Assessment of the new measurement techniques
            Equivalency of open loop and closed loop reactivity measurement techniques
        3.1.3. Benchmark analysis based on existing experimental results
            BFS-73 (IRPhE data base), FCA IX-1; IX-7; possibly IX-6
    3.2. Proposal of new experimental program at experimental facilities for international collaboration

Outline

- OECD/NEA Mission and Membership
- Modelling and Validation
  - Nuclear Data for Advaceded Reactors
  - Databases of Integral Experiments
- **Reactor Systems, Materials and the Fuel Cycle**
  - Sodium Cooled Fast Reactor Studies
  - Heavy Liquid Metal Technologies
  - Innovative Fuels & Materials
  - Advanced Fuel Cycle Scenarios, P&T, Recycling Technologies
- Advanced reactor systems
  - Regulatory and Safety Issues
  - Future energy market needs
- Concluding remarks and proposals for collaboration

Uncertainty Assessment in Modelling of SFRs (UAM-SFR)

Working Party on Scientific Issues of Reactor Systems

Annual UAM-11 workshop devoted to uncertainty analysis in modelling of LWRs and SFRs. Erlangen, Germany, hosted by AREVA NP GmbHTh on 8 -12 May 2017

- UAM-SFR is continuation of completed SFR-TF (Sodium Fast Reactor Feed-back and Transient Task Force, 2011-14)
- UAM-SFR considers uncertainties for
  - Large SFR: 3000 MWth MOX-fuelled core (CEA)
  - Medium SFR: 1000 MWth metallic-fuelled core (ANL)
- Static calculations of reactivity feedbacks and kinetic parameters
  - SFR-TF considered: k_{eff}, $\Delta\rho$ (burn-up), power distribution, CR worth, $K_{Doppler}$, Na void worth, reactivity of 1% of perturbation of Na density, Structure density, Fuel density and Fuel axial elongation, Grid expansion and β_{eff}
  - UAM-SFR considers their uncertainties (due to nuclear data – nowadays status)
- UAM-SFR : transient studies
  - Unprotected Transient Over Power (UTOP) with 0.5 $ insertion in 15 sec with uncertainties

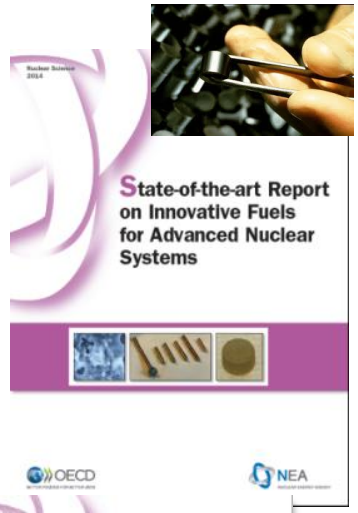
https://www.oecd-nea.org/download/sfr-uam/SFR-UAM-3.html

Fuels and Materials for Fast Reactors

Working Party on Scientific Issues of the Fuel Cycle (WPFC)

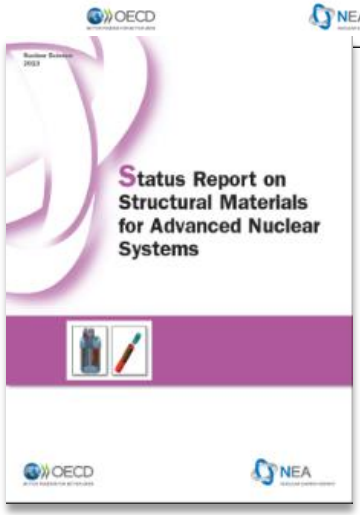
Innovative fuels containing MA

- Oxide, nitride, metallic and dispersion fuels, different mechanical forms
  - State-of-the art report (2013)
  - Benchmark on fuel performance codes
  - Fuels properties for fast reactors (potential DB)



Structural Materials for Gen IV systems

- Status report (2013)
- Report on Grand challenges for adoption of Materials in Modern Reactor Applications (under preparation)
  - Motivation for use of advanced materials requirement and path to qualification
  - Common challenges: qualification needs, fabrication and joining technologies
  - Irradiation effect testing



Coolant Technologies

Working Party on Scientific Issues of the Fuel Cycle (WPFC)

Objective: "translate" fundamental scientific understanding to application to support:

- Development of construction codes used for design
- Key technical issues for licensing
- Recommendations for Operation, Inspection and Handling

Scope:

- Environmental conditions and factors that affect materials behaviour relevant for the structural integrity of confinement barriers and components
- Coolant and cover gas issues
- Thermal-hydraulics of liquid metals

Ongoing activities:

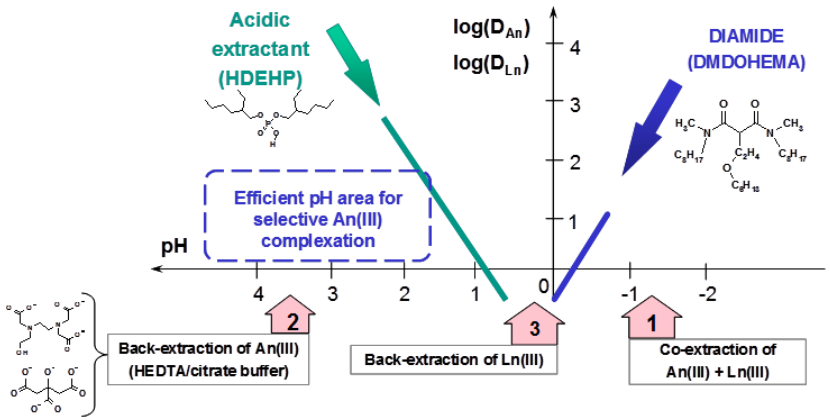
- Material data management :
  Information system for collecting and disseminating the material data
  Final draft of the report being reviewed- Report to be published in 2017
- Effects of Environmental conditions on material behaviour:
  Structural integrity of confinement barriers and components
- Coolant and cover gas issues

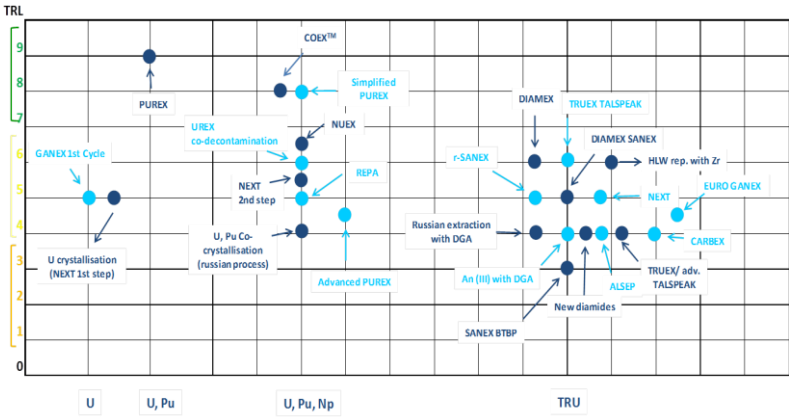
Minor Actinide Separation

Working Party on Scientific Issues of the Fuel Cycle (WPFC)

State-of-the-art report on Progress on Separation Chemistry, MA Separation and Perspective of Future R&D

- Status of current technologies for the separation of minor actinides
- Report is being edited
- Report content:
  - Progress of Separation Technology and Current Achievement
  - Process Criteria
  - Comparison of Chemical Processes
  - Perspectives for Future R&D

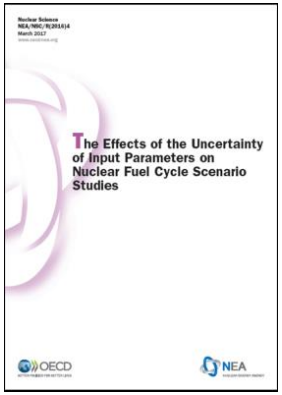




Advanced Fuel Cycle Scenarios

Working Party on Scientific Issues of the Fuel Cycle (WPFC)

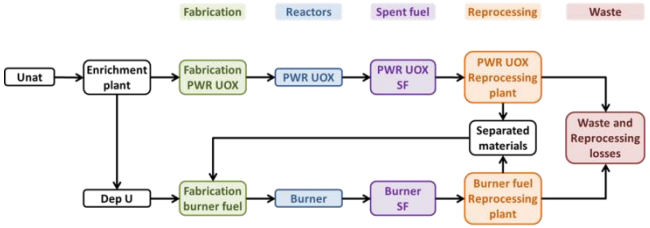
Benchmark study on the effects of uncertainties of input parameters on nuclear fuel cycle scenarios studies.



- Report published in 2017.
- Evaluation of the effects of the uncertainties of input parameters on the outcomes of fuel cycle scenario studies.
  - Scenario development requires estimation of values for multiple input parameters for up to 200 years into the future. This activity has improved understanding of the impacts of these estimations on analysis results.

Study on management of transuranics

- **Objectives**
  - Evaluate how much TRU in spent fuel can be burnt with different “burner fleets”
  - Assess possibility to go back to equilibrium state after reduction of TRU stocks
  - Compare codes and models



Time (y)	PWR UOX (TWhe/y)	Burner fleet (TWhe/y)
0	430	0
80	430	0
110	0	430
300	0	430

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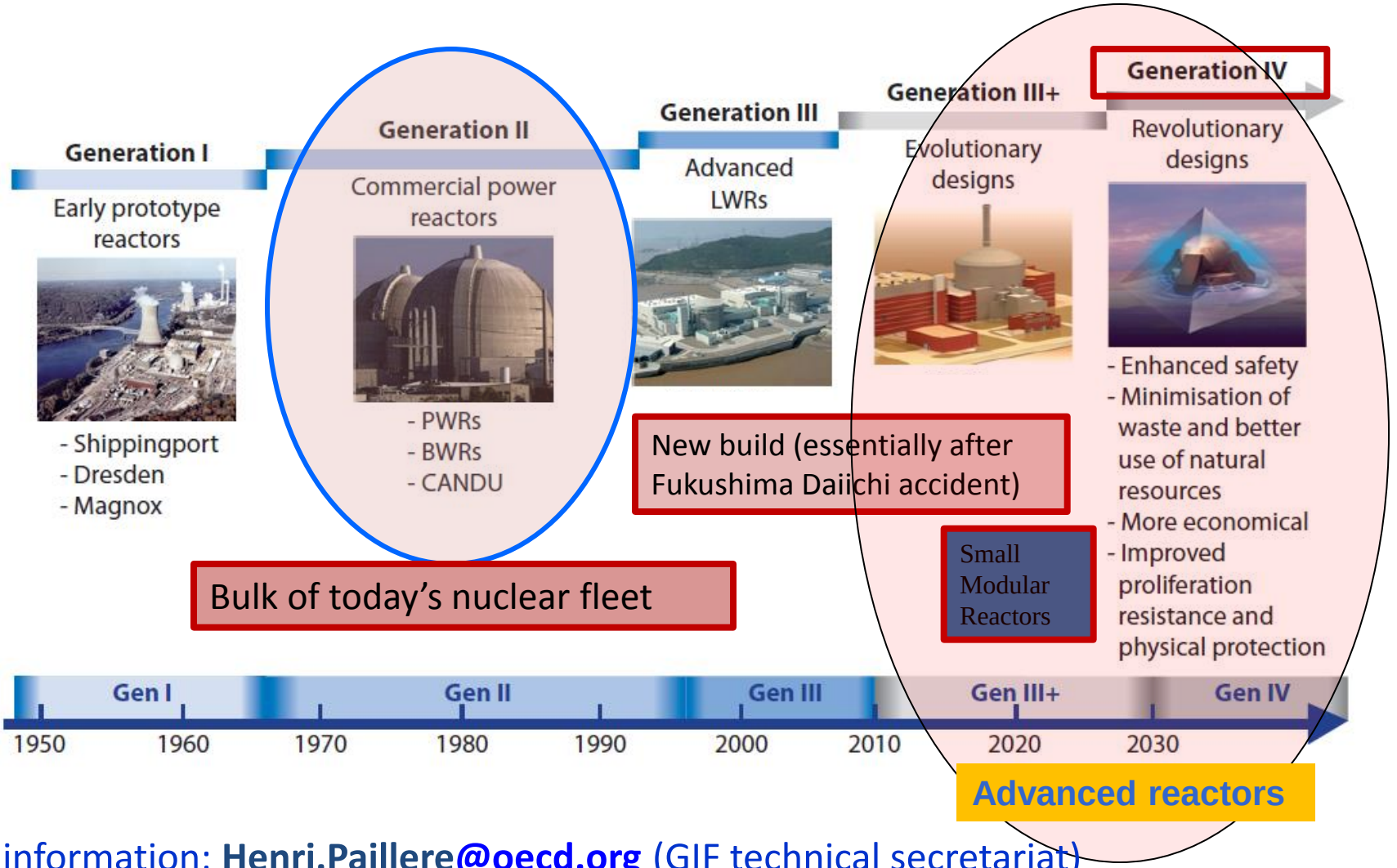
Joint CNRA/CSNI Ad-hoc Group on the Safety of Advanced Reactor (GSAR)

- GSAR has been established by the joint CNRA/CSNI decisions in December 2014 to discuss regulatory and safety issues related to GEN IV designs
- 9 member countries (USA, France, Russia, China, Japan, Korea, Germany, Italy and Canada) + 2 observers (IAEA, EC)
- GSAR will provide regulatory perspective through the issue of reports containing discussions of areas in which additional or revised regulatory approaches, including safety research, may be needed to facilitate effective regulation of advanced reactors
- GSAR members agreed to select a sodium fast reactor for their pilot study (4 technical areas - severe accidents, neutronics and criticality safety, analytical codes, fuel qualification)
- GSAR will take into consideration the GIF safety design criteria, and the development of the GIF safety design guidelines

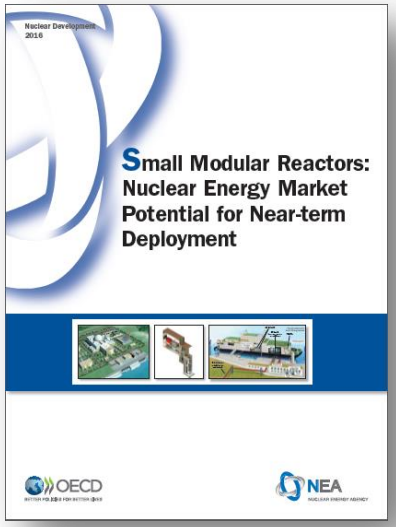
More information: **Victor.Neretin@oecd.org** (NEA technical secretariat)

GIF Workshop: Advanced Nuclear Reactors



More information: **Henri.Paillere@oecd.org** (GIF technical secretariat)

Scope of the Workshop



Workshop held on 12 April 2017 addressed future role, markets and challenges for:

Evolutionary LWR, SMR, Gen IV systems

Role of innovation

Over 120 participants, including industry (vendors, utilities), research, regulators, energy analysts & economists

More information: **Henri.Paillere@oecd.org** (GIF technical secretariat)

New Activity "Advanced reactor systems and future energy market needs"

All presentations available: https://www.oecd-nea.org/ndd/workshops/arsfem2017/

Nuclear and climate change:

- Nuclear key component of decarbonisation scenarios (e.g. IEA 2 deg. or well below 2 deg.)

Electricity markets:

- Increased electrification
- Integration of large shares of variable renewables
- Flexibility requirements (generators / system)
- Future of nuclear baseload debated

Regulatory aspects:

- Licensing frameworks
- Environmental regulations (eg. Water, pollutants) can also impact nuclear technology/deployment
- Codes & standards harmonisation needs

Advanced reactors:

- Scale (large vs. SMRs) / economy of scale vs. Economy of multiples
- Technological aspects: higher temperatures/coolants, enhanced safety, flexibility, but also economics?
- Non-electric applications

Innovation: as an enabler

More information: **Henri.Paillere@oecd.org** (GIF technical secretariat)

Concluding Remarks

- **Increased level of interest in continued development of advanced nuclear systems and fuel cycles**
  - **better use of natural resources**
  - **minimisation of waste and reduction of constraints on deep geological repositories**
- **Ambitious R&D programmes on-going at national level in many countries, also through international projects**
  - **expected to lead to development of advanced reactors and fuel cycle facilities**
- **OECD NEA will continue to support member countries in field of fast reactor development and related advanced fuel cycles**
  - **forum for exchange of information**
  - **collaborative activities**

Proposals for Collaboration

Establish links in the area of Reactor Physics and Integral Experiments:

Use integral experiments data discussed at the IAEA CRPs to create benchmark (IRPhEP) quality data for validation purposes

- Reactor Physics: NEA representation in the related CRPs (for example, CEFR start-up experiments)
- Thermal-hydraulics: data for validation of CFD codes

Congratulations on TWG-FR 50th Anniversary!

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